Progress Report 2007
Human Dimensions of Global Change Research (HDGCR) Program

Project Title

Decision Support System for Agricultural Applications of Climate Forecast in West Africa

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I. Preliminary Materials

A. Project Abstract

Farmers in Ghana require both the long-lead climate forecasts, downscaled to their region, as well as advice and inputs from local support services (i.e. meteorological services, ministry of agriculture, financial institutions and extension agencies). It appears that the support services sector is unaware of the emerging capacity in climate science in forecasting rainfall. Peanut is not only a major high-protein and major vegetable oil food in the Ghanaian diet, but it is also a cash crop and the cake remaining after oil extraction offers high quality feed for animals. Because local and international markets exist for peanuts, they provide an essential opportunity for small-scale subsistence farmers, many of whom are women, to generate income and improve living standards for themselves and their families. This research project is developing climate-forecast-based decision support systems that will enable support services to routinely evaluate risks and opportunities for crop production in Ghana using climate forecasts. We are exploring with a family of crop models, how various responses to ENSO events might affect crop production. In the second purpose, our goal is to assess the potential added value of providing more information to support services and farmers than is currently available through climate forecasting. This will be achieved by coupling climate forecast information with further model analyses to provide a better context for decision makers and producers, and then ask if this more elaborate information gives them any more flexibility and decision options than the climate data alone. In the third phase, we will design and test the decision aids that would be needed by support services so they can provide logistical support to farmers. Improved climate and weather information will lead to more informed management decisions and reduced risks for yield losses.

B. Objective of Research Project

This research project will assess the factors- both scientific and societal – affecting the use of long-lead climate forecast by government, banks, and extension services (referred to as support services hereafter) and to develop information for use by farmers for making informed decisions. We have four specific objectives to be achieved over a three-year duration: (1) Document knowledge of climate variability and its impact on peanut production among the major stakeholders in the agricultural sector in Ghana and determine how these stakeholders use (do not use) the knowledge to plan their operations, (2) Develop a climate diagnosis system for downscaling climate forecasts at different locations and for various times of the year and disseminate them along with a package of recommendations for managing crop production though existing mechanisms and institutions., (3) Develop decision aids to forecast the impact of climate variability on peanut production and to inform all stakeholders of those risks and management options that reduce them, and (4) Evaluate the use of decision aids within in each institution and how it impacts policy decisions they make and ultimately how it benefits peanut farmers.

C. Approach by objective

1. Using a participatory interactive process we will synthesize how the effects of climate variability are perceived and how climate forecasts and products are used (or not used) by stakeholders in support services sector as well as farmers. Through this objective we intend to address an important goal of the HDGCR program by focusing on several essential but weak institutions that empower societies' use of climate forecasts in developing countries.

2. Highly erratic rainfall and low water holding capacity soils are major features of Ghanaian production systems. Therefore any advice needs to be site specific. To achieve this we will collect a comprehensive historical daily weather data in pilot study regions. Weather data at each location will be categorized by October-December ENSO phase. Then statistical methods will be used to determine the underlying probability distributions of monthly rainfall and temperatures associated with each ENSO phase at each location. In doing so, we will endeavor to present climate information as a starting point in discussing climate variability and climate forecasts, which can be used by stakeholders to assess risks. We will model the daily weather data using a locally adapted weather generator conditioned on ENSO phases for input into a peanut crop model. Repeatedly using the generated daily weather series, consistent with a given climate forecast, and a peanut crop model, we will obtain frequency distributions of yields under forecast climate scenarios. This forecast-specific frequency distribution combined with each alternate peanut management decision will create a probability distribution to facilitate risk assessment and further decision-making.

3. Studies in the USA, Australia, and some parts of Africa have reported that seasonal climate forecasting offers potential for improving management of crop production risks. The situation in W. Africa is unique; it appears that farmers there are most likely to benefit if seasonal climate (i.e. rainfall) forecasts are distributed as an integral part of an extension package that includes discussion of the nature of the forecast, potential response strategies, and risk management options. A range of tools and concepts have been developed to deal with the need to reduce economic loss in dry years, while taking advantage of good seasons by adjusting inputs, management, or crops. These include response farming in which the crop is managed in accordance with the rainfall prediction based on the date of onset of the rains and actual amount received in the early part of the season. Other tools include crop simulation models linked with models of daily rainfall accounting for El Niño effects. We will pursue several participative systems approaches involving simulation-aided discussions with support services and decision makers for understanding and analyzing decision processes as they relate to use of climate forecasts to assist farmers in Ghana.

4. *Evaluating the use of decision aids within in each institution* will enable us to identify and resolve problems to operationally use the prototypes decision aids to be developed. We will work with all stakeholders to evaluate the utility of the systems and to obtain feedback to improve it. We will also identify what adjustments in the climate forecast tools/products can be made to maximize the probability that stakeholders will take action and correctly use the products. Support services personnel from each of the three Agroecological zones (Humid, Savanna, and Semi-arid) will be invited to participate in training program given jointly by both the UF and Ghanaian teams.

D. Description of any matching funds used for this project.

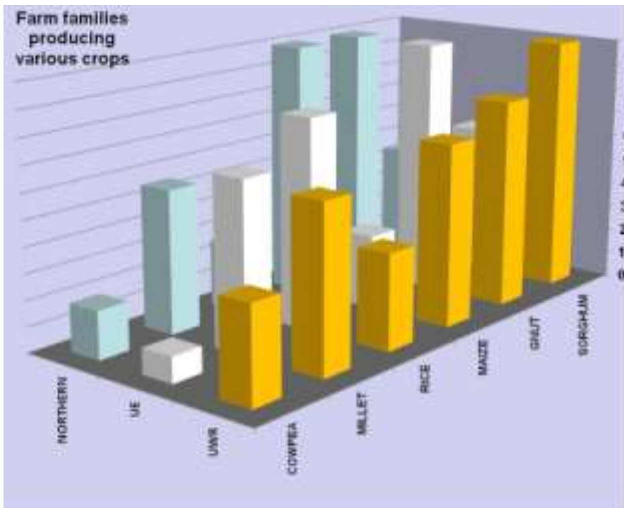
The project is paying 50% of the salary support for PI. All other co-operators are being paid by their host institutions. We estimate that additional matching support from UF amounts to $20,000/year and that from the four Ghanaian collaborators about $ 50,000/year.

II. Interactions

1. **We conducted surveys in three districts to document role of groundnut in the food security**
2. **55-years of historical data at Wa was analyzed to document climate variability and how it has affected the growing seasons**
3. **Conducted a review of traditional capacity for weather prediction in Ghana**
4. **Documented indigenous knowledge and farming communities information need**
5. **We document lessons learn when applying the Decision Support System for Agricultural Applications of Climate Forecast for the 2007 cropping season**
6. **We conducted an analysis of the role extension plays in delivery of climate forecast**

Accomplishments 1.
Base-Line Data: Food Security and Groundnuts
Shrikant Jagtap

Background – Our analysis of historical crop production record of MOFA(1997. Agriculture in Ghana. Facts and figures. Policy Planning, Monitoring and Evaluation. Ministry of Food and Agriculture. Accra, Ghana) showed that peanut cultivation is a major agricultural activity for the people of the northern regions of Ghana with more than 80% of farm families cultivating peanuts (Figure 1). Based on 2003 prices from the same MOFA source, g'nuts attracts three times more market price than staples maize and millet per 100 Kg.



From the view point of household food security, g'nut serves as a major source of vegetable protein and is used extensively in many dishes. Roasted peanut is eaten as a snack in combination with bananas. Peanut butter is extensively used in the preparation of soup in homes and also as bread spread. The kernels are pressed for oil. This activity is a major source of income for rural women.

The peanut cake derived after the oil extraction is also used in the manufacture of other local delicacies that are rich in proteins. Hence they are an important item in the food chain to improve the nutritional status of children, women and the aged. In terms of access, peanuts are cheaper than animal product as a protein base.

As a cash crop, peanuts provide opportunity to earn an income thus increasing the family's ability to purchase a better quality food resulting in improved nutrition. Since peanut production is labor intensive, it generates local labor demand and thus employment for sowing, weeding, harvesting and cracking. These economic interactions generate income for the hired labor and thus in such agriculture labor households, the access to food could improve.

The peanut crop as a nitrogen fixating crop improves the soil fertility in these fragile and stressed ecosystems. Improved soils are put to cultivating other crops. A diversified cropping system adds to the income potential that could mean more food for the farm household.

Accomplishment 2.
Knowledge of Climatic Variability AT Wa
Shrikant Jagtap and J. Naab

Rainfall for the southeastern regions in Ghana is linked to October to December ENSO phase of Nino3 region (Opku-Ankomah and Cordrey, 1994; Adiku and Stone, 1995). Further studies were required to expand this analysis to moist savannas and especially to the semi-arid regions of northern Ghana where agricultural activity is very extensive. Conceivably, the coupling of rainfall predictability to a crop growth models would enable the prior assessment of crop productivity and assist in making decisions either to exploit a good coming season or offset a bad one using various management options. Therefore Wa, located in the Upper West Region (UWR) of Ghana (Figure 1), with a long history of rainfall records was selected for this project. The major sources of livelihood for the community are farming (crop & livestock). The predominant crops cultivated in the upland in order of importance (area cultivated) are millet, sorghum, cowpea, groundnut, maize and rice while those cultivated under irrigation are vegetables. A major constraint to increased agricultural production in the community is year to year variability in rainfall and its trend over years as illustrated in Figure 2. 10-year mean rainfall decreased between 1968 and 1990 from 1180 mm to 880 mm. Farmers told us that it is extremely difficult to

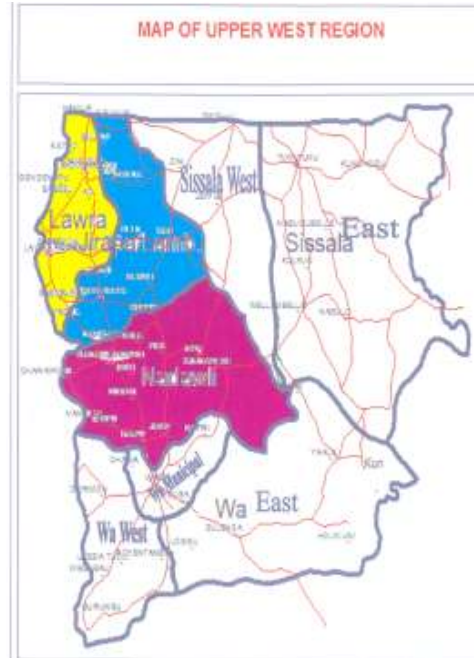


Figure 1UWR

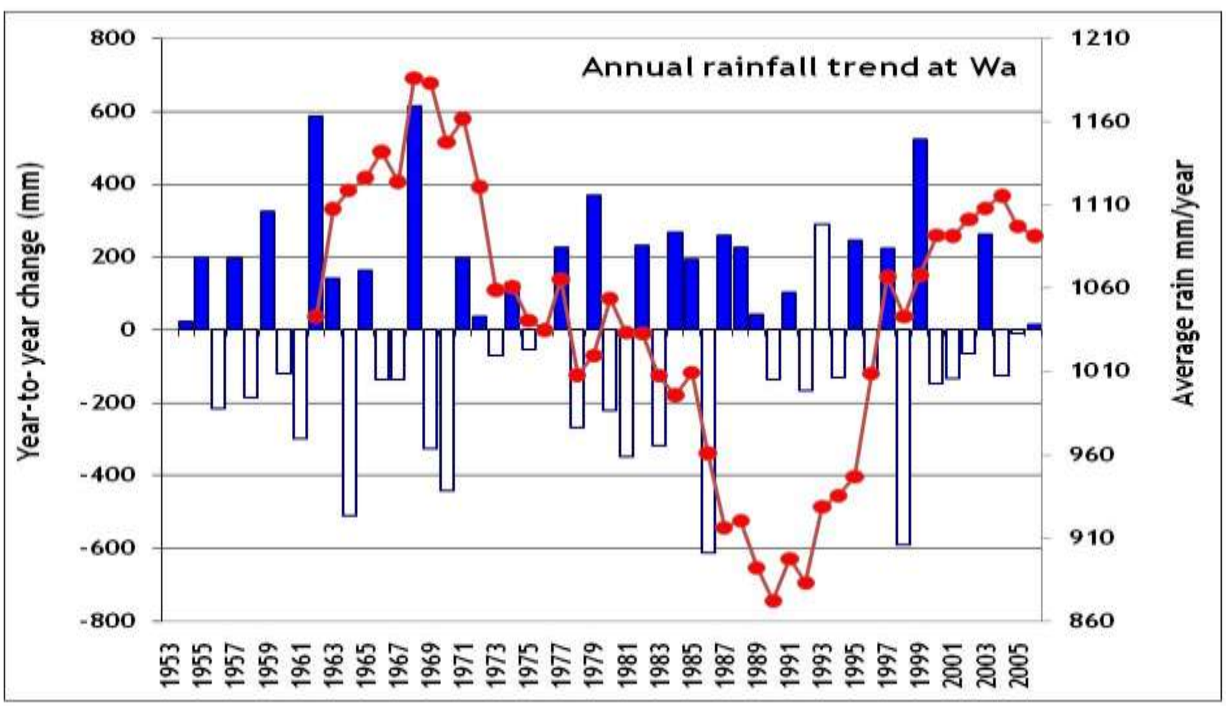


Figure 2

manage year to year change which can range from a lower rainfall year change of 942 mm as in 1969 to excessive rainfall of 1114 mm in 1999, when transitioning from an El Nino to La Nina year. Therefore, farmers of Wa want to forecast that tells them how the current year is likely to be relative to the previous year. After 20-years of decreasing rainfall it has been steadily increasing since then, but the year-to-year changes remain as high as before.

In addition to year-to-year changes, the farmers in have also noticed that the length of growing season has shortened from 6 -7 months to about 4-5 months (Figure 3). Usually 50mm/month of adequately distributed rains is sufficient for sowing and establishment of crops and 100 mm/month for their growth. Both rainfall data (Figure 4) and farmers experience confirmed that sowing is rarely possible in March now, which was possible 20-years ago. Earlier the farmers practiced relay farming, but with decrease in the length of growing season this practice has declined of recent. Most of the farmers practice mixed cropping systems with millet being the main crop intercropped with sorghum, groundnut, cowpea or both. Often maize is intercropped with sorghum.

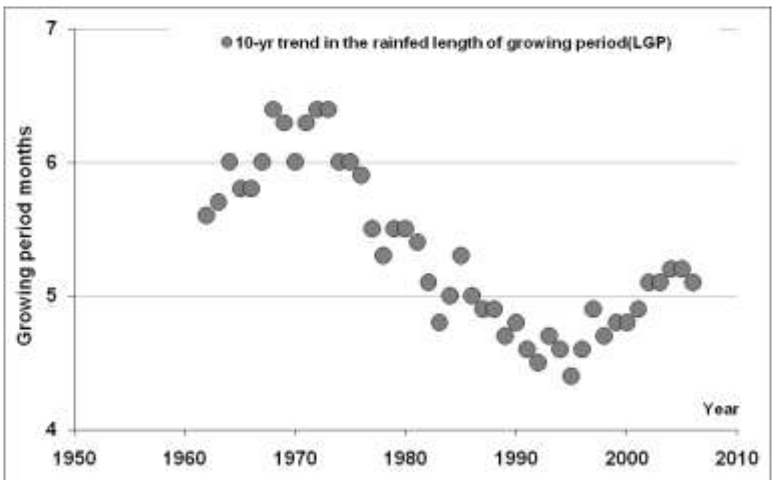


Figure 3

According to the farmers, intercropping is to channel bare soil evaporation through a crop and thus obtain some yield along the way.

Farmers are getting weary of year to year changes in rainfall amount and season length. This can be confirmed by long-term analysis of monthly rainfall as shown in Figure 5. In addition to historical trends in monthly rainfall amounts, there appears to be some trend in the last 10-years since 1996. Rainfall in April has been at least over 50 mm/month is increasing, while the rainfall in May and June is also decreasing over the sane time period. June rainfall is particularly low in El Nino years.

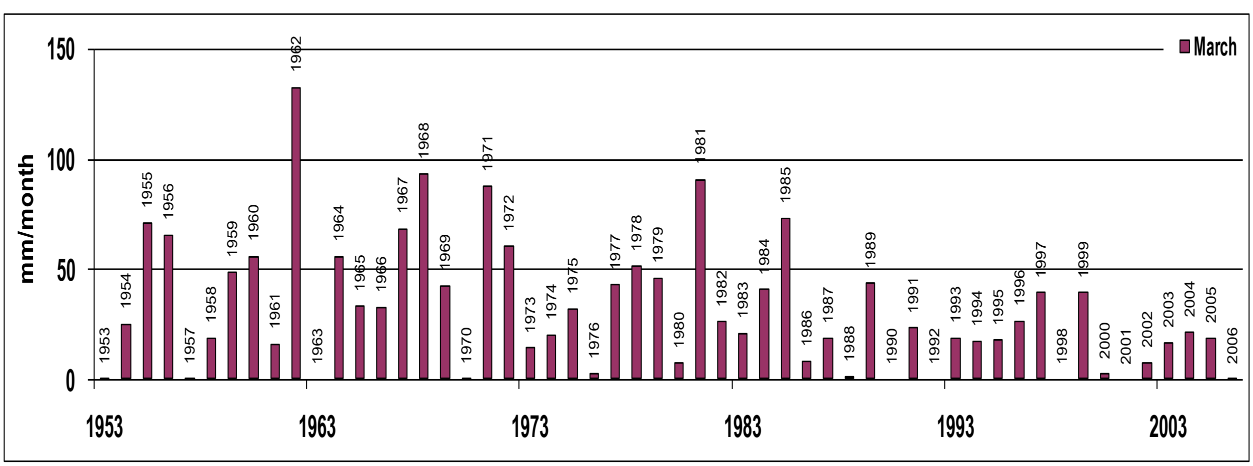


Figure 4

Our 2007 survey of 74 farmers from 50 villages showed that groundnut farmers have adapted to this rainfall pattern. Peanut sowing is done well before June, bulk of it occurs in April and May.

Figure 5

Accomplishments 3.
Traditional Capacity For Weather Prediction In Ghana
Shrikant Jagtap (sjagtap@cox.net)

Authors experience showed that the farmers had good understanding of weather and climate of their community and has several time-tested indigenous methods for forecasting rain-fall onset, establishment and overall quality of the rainy season. They characterize a year into five seasons based on the atmospheric temperature as felt by the body, changes in wind direction, farming activities, and the behavioral changes of some animal and birds and phenological changes in plant species. The five seasons are: *cold(Dec-Jan), dry(Feb-Mar), hot(Mar-Apr), rainy(Apr-Sept) and harvesting(Oct-Nov).* The most popular and reliable method of predicting possibility of onset of rainfall within a week or two, is based on changes in wind direction from the west towards the east. The complete defoliation of the *Fadherbia albida* tree occur followed with profuse flowering is rated next in term of reliability. They also claim that their method for predicting the start of rain is correct in 8 years of the last 10-years. Farmers use these predictions for land clearing and land preparation. Ridging starts after yet another heavy rain.

The farmers do not plant no matter the intensity of the rainstorm is unless they observe a sustained change in wind direction from west towards east. Once rains are established, planting may commence if the soil is moist determined by using a local hoe to dig the soil and determine the depth of moist soil or after a heavy rainstorm. Onset of rains may triggers planting of drought tolerant crops such as millet (*Pennisetum glaucum L.R. Br.*) and sorghum (*Sorghum bicolor*). They wait further for rains to establish before sowing input intensive and drought sensitive crops.

Farming communities agreed that their traditional forecasting methods rarely work for the distribution of rain within the year. But, they can predict the overall rainfall situation in a year by observing where on the trees birds were nesting. For example, in 2007, as birds started nesting high in the trees, instead on small bushes, was sufficient to sign elders that it would be a drought year. Realizing this they started to clear more lands for planting. There were no rains for four weeks from Mid June to mid July and again in late September early October. Many maize fields were destroyed in 2007.

Farmers did not have access to scientific weather forecast until this project. Farmers recommended an integration of traditional methods with scientific methods to evolve reliable forecast methods. By perceiving such a knowledge base, it may facilitates social interaction and promote acceptance of scientific forecast among the farmers. This project is now prematurely ending, just as forecast applications were beginning to be accepted by communities around Wa.

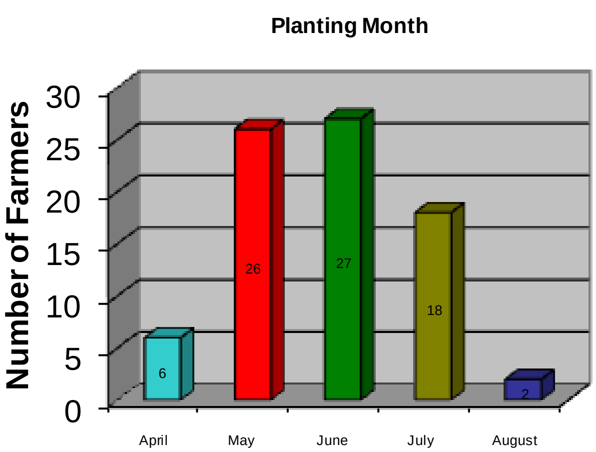
Accomplishments 4.
Indigenous Knowledge and Farming Communities Information Need Assessment

Shrikant Jagtap, S. Adiku, J. Naab, El Eledi

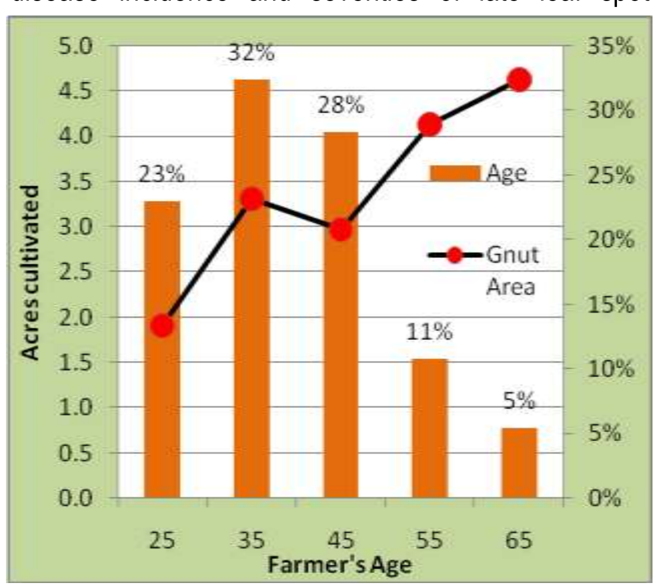
Activities – Participatory surveys were conducted in 2006 and 2007 to document knowledge of climate variability and agricultural productivity among the farmers and how they use indigenous knowledge to support and manage peanut production.

Methodology – Individual and group interviews were conducted by a team of socioeconomist, agronomist , extension agents and climatologist in farmers own environment.

Results – Farmers revealed that not only rainfall is erratic it has shifted and become shorter than what was 20 years ago. As a result now they plant later in May as compared to April before. Majority of the farmers (82%) now plant short duration varieties although they yield less than longer duration cultivars. Most of these groundnut farmers tend to be younger and educated but they are likely to cultivate fewer groundnut acres than those over 50 years of age. This was generally attributed to the cash value of groundnut which was deemed essential to support larger families of older farmers. Although family size is generally large (above 10), most of them are school going children. So farmers prefer varieties that are easy to work with and have good market demand.



Researchers have known for many years that peanuts in the Upper West Region of Ghana suffer from high disease incidence and severities of late leaf spot (Cercospora personatum) and rust (Puccinia arachidis). This disease often causes complete crop failure in a wet year. But farmers and extension agents we spoke to were not aware of this, and they often link crop maturity to leaf defoliation as a result of diseases thus overlooks the adverse effects on their crop. Most women who plant, did not know why their husband and extension were unnecessarily taxing them by asking to plant in rows and maintain uniform spacing.



Findings - Opportunities exist to integrate climate forecast to improve the information flow from researchers to extension and ultimately to farmers. This information on sowing and variety preferences helped us develop and delivering enhanced risk management products to peanut farmers so that they can make better use of seasonal climate forecasts.

Accomplishments 5.
Decision Support System for Agricultural Applications of Climate Forecast in West Africa
Lessons Learnt in 2007

S. Jagtap (sjagtap@ufl.edu) with
E. Eledi, K. Wih (MOFA, Ghana) & J. Naab (SARI, Ghana)

Background - This NOAA funded project was launched on the hypothesis that West African Farmers will respond to the long-lead climate forecasts as a tool for enhancing agricultural productivity as long as various support services (i.e. meteorological services, ministry of agriculture, financial institutions and extension agencies) will provide the needed forecast on-time and loan forecast-dependent logistical support such as agricultural inputs, credit facilities, and advice.

Our 3-years experience suggests that this hypothesis was only partially valid for farmers in Wa and its surroundings as vividly illustrated by the results of how farmers responded to forecast in 2007. The 2007, was an El Nino year according to the JMA index (Mavromatis et al., 2002[1]). Using the ENSO-phase based climate forecast, we advised the Ministry of Food and Agriculture (MOFA), the extension service in

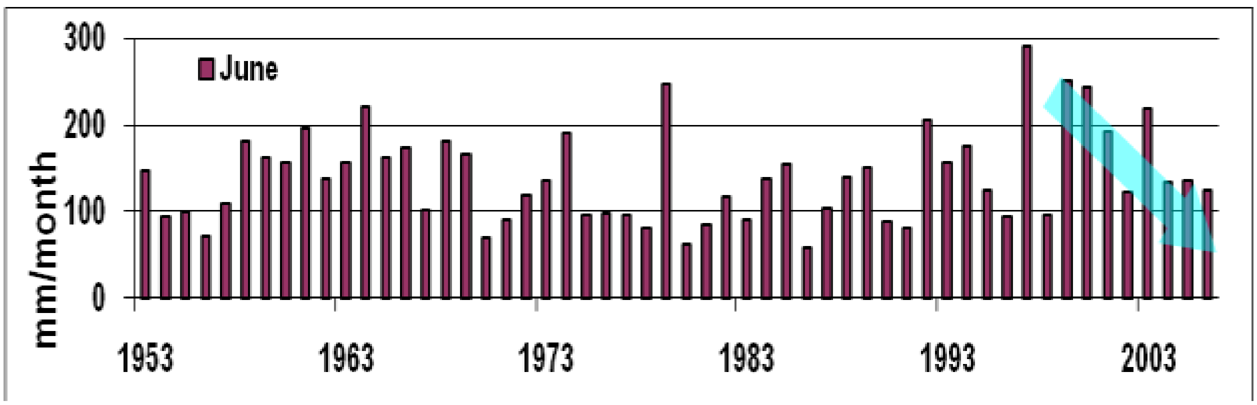


Figure 6 Declining June rainfall in recent years

the region, to let farmers know to be watchful of rainfall break in the month of June. Furthermore, the forecast advisory based on climate forecast and DSSAT-PNUTGRO simulations recommended farmers in April to plant as soon as rain arrives in April to May. Our simulations showed that once the peanut crop was established before June it had a better chance of surviving the potential rainfall uncertainty in June. Rainfall in June has been knowntobeerratic and steadily declining over the last 10-years (Figure 1) at Wa and farmers are aware of this phenomenon.

The extension services in Wa did not take this advisory to farmers. Farmers were relaxed by heavy rains in April and May and delayed sowing as illustrated by our survey of 74 farmers in 50 villages. A large majority of the farmers waited to sow till June (**Figure 2**). Those who planted around mid-June saw very little rain for three weeks in Wa between June 20 and July 10. Many peanut and cornfields failed to germinate and those, which germinated, only few plants survived. There was a panic and a fear of looming hunger in the region. At the request of MOFA, a new climate outlook advisory was prepared for peanut farmers using IRI's June forecast (http://iri.columbia.edu/climate/forecast/net_asmt/).

[1] Mavromatis, T., Jagtap, S.S., and Jones, J. W., 2002. El Niño Southern Oscillation Effects on Peanuts yield and nitrogen leaching. Clim Res, 22(2):129-140

2007 Climate Advisory - The updated July to October forecast called for above normal rainfall through November. DSSAT-PNUTGRO simulations using updated forecast revealed possibility of substantial yield losses due to leaf spot disease. Technically above normal rainfall brings a new set of challenges to the peanut cultivation in this region. Cercospora leaf spots disease is endemic in all the production areas in northern Ghana. Leading researchers in the region (Naab et al., 2005[2]; Tsigbey et al., 2001) have shown that yield losses due to this diseases are close to 100% in a wet year. Seasons with moderate rainfall could result in yield reductions ranging 28->50%. In order for cultivation to be feasible, peanuts needed to be sprayed.

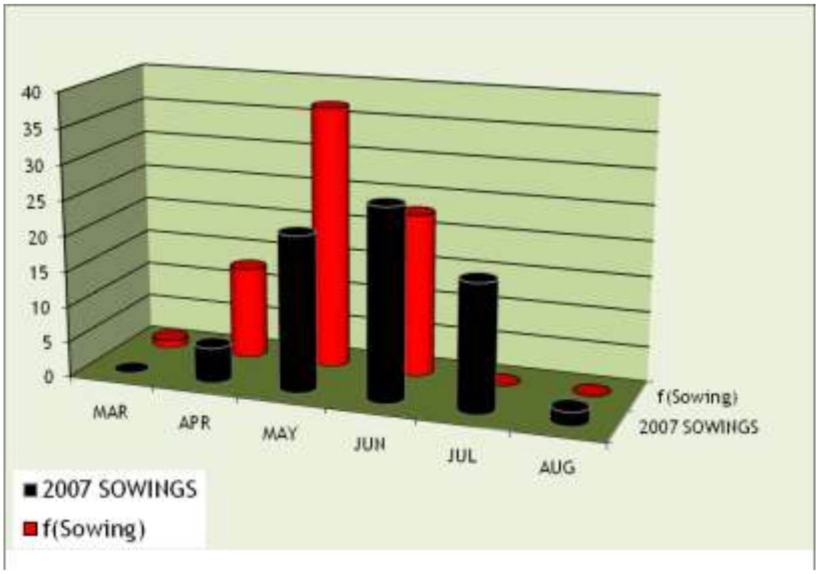


Figure 7 Comparison of usual sowing calendar f(Sowing) and reality in 2007

Our surveys in 2006 and 2007 had revealed that Wa farmers were not accustomed to sowing peanuts beyond June (Figure 2). Since peanut sowing after June was unheard off, farmers as well as some extension agents were skeptical of sowing peanuts after June. Nobody believed that groundnut could be planted so late and yet harvested before rainfall ceases.

Therefore it was clear that farmers were not likely to sow groundnut if they could not control cercospora leaf spots disease. They needed inputs of a short duration peanut variety, fungicide and sprayers to control the disease as well as guidance from MOFA on methods to control the disease. It was as a result of this that MOFA, SARI and University of Florida organized a meeting on June 14 with area farmers and explained them the forecast and how to manage their peanut fields. Using the project funds, farmers were given seeds of groundnut variety *Chinese*, 100-day erect variety preferred by almost 70% of the farmers in this area. They were also provided with knapsack sprayers for each community to be shared by farmers and liquid and powder fungicides were purchased from a local dealer. Fungicide costs about 10 Gh CD (i.e. Ghana Cedis) per acre to combat the incidence of groundnut leaf spot which invariably limit the yield.

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2 Tsigbey, F.K, J.E. Bailey and S.K. Nutsugah. 2001. The lost harvests: Impact of peanut diseases in northern Ghana and strategies for management Paper presented at the 39th Congress of the Southern Africa Society of Plant Pathologists. 22nd -24th January 2001

NAAB, J.B., TSIGBEY, F.K., PRASAD, P.V.V., BOOTE, K.J., BAILEY, J.E. & BRANDENBURG, R.L. (2005). Effect of sowing date and fungicide application on yield of early and late maturing peanut cultivars grown under rainfed conditions in Ghana. *Crop Protection* **24**, 325-332.

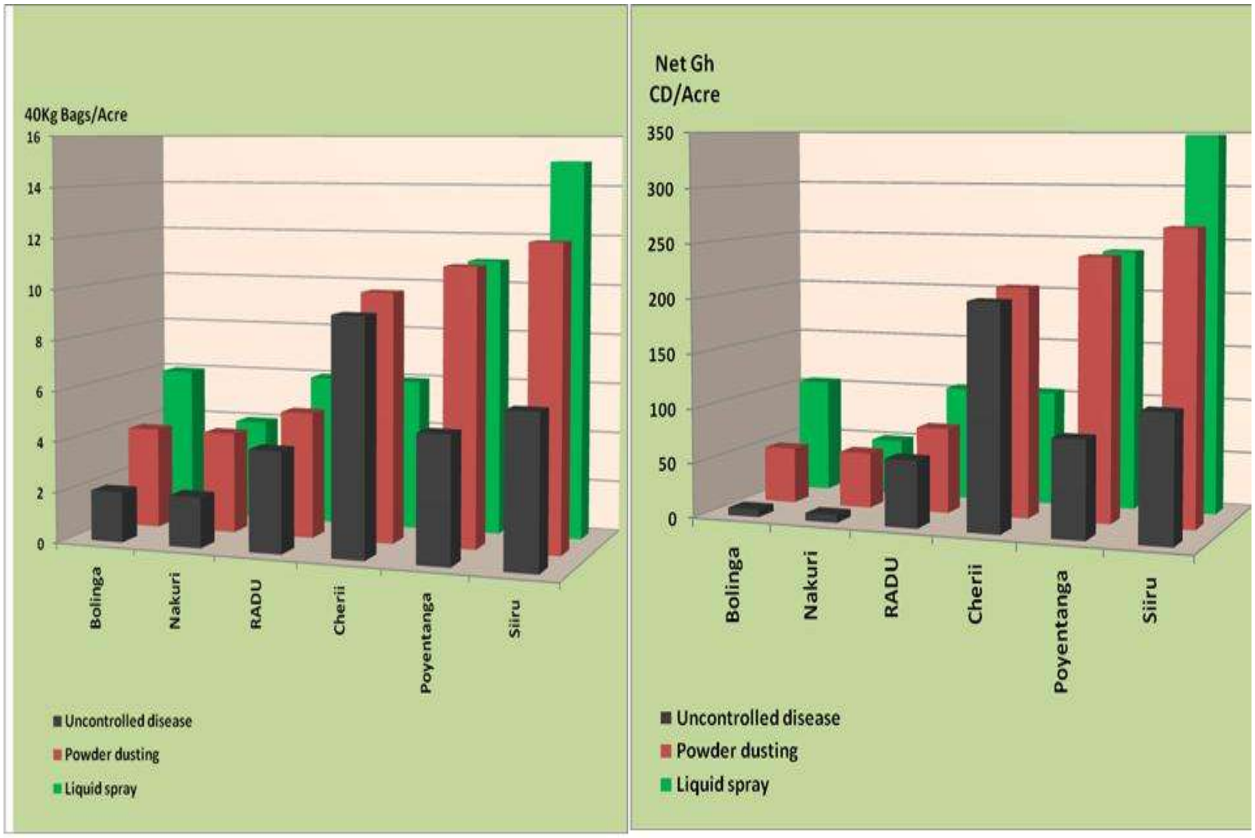
Forecast Demonstration- 25-farmers agreed to try the forecast and peanut management recommendation derived from the DSSAT-PNUTGRO simulations. These farmers came from all three district, Wa East, West and Municipal (**Figure 3**) in the region. These farms were situated such that many village farmers could witness routinely the performance of the field under trial. Farmers were advised to plant in rows. Typically farmers walks along an imaginary straight line and dibbles after each step. Women who follow them put a seed in the hole and cover it with soil. Thus the sowing depth is highly variable making emergence variable.

Advisory Validation - Five farms from the total of 25 farms were selected for rigorous monitoring. An extension agent was assigned to work with three of these farmers (Siiru, Poyentanga, Cherii) on a regular basis. Farmers in Nakori and Bolinga received minimal assistance. Most farmers planted their fields before July. The sixths demonstration was set-up by the MOFA itself (RADU) to demonstrate their staff the value of climate forecast. The RADU field was sown late on August 18, 2007. The cost of production per acre (unit preferred by farmers) was 57 GhCD (25 ploughing; 6 planting; 10 fungicide; 10 weeding and 6 harvest). Yield in Kg/Acre was first converted to 40Kg mini-bags (Figure 5, popular unit among farmers) and later to net return by using the 2006 price of 27 GhCD/Bag (Figure 5). Across six-sites peanut yield from uncontrolled fields was 4.7 bags/Acre compared to 7.7 and 8 bags/acre

Figure 8 The Upper West Region, Ghana

Figure 9 Six demonstrations on climate forecast and peanut growth management

when sprayed with powder and liquid fungicide. Yields from demonstration fields routinely visited by the extension agents (Cherii, Poyentanga and Siiru) clearly outperformed those left to be managed by farmers in Nakori and Bolinga. Also, plots at MOFA (RADU) which were sown about three weeks after farmers,



yielded low.

In final analysis, frequent interactions between farmers and extension advisors led to better harvest and better returns to farmers. Better harvest meant considerable higher net returns and better lives for farmers. Wa farmers responded spontaneously to the climate forecast and did not demand it several months in advance. Access to inputs remains their major concern.

Potential Economic Value of Climate Information – According to MOFA estimates peanut production area is about 63,975 ha in the Upper West Region. From the 2007 demonstration trials on the six farms, the mean gross returns were 216 (liquid spray), 207 (powder dusting) and 127 (no control) Gh CD/Acre, respectively when peanuts were sown and managed according to the forecast. If farmers were to adopt the recommended practices, with today's area, this translates to gross returns of over 20 million Gh CD. Peanut is not only a major high-protein and major vegetable oil food in the Ghanaian diet, but it is also a cash crop and the cake remaining after oil extraction offers high quality feed for animals. Because local and international markets exist for peanuts, they provide an essential opportunity for small-scale subsistence farmers, many of whom are women, to generate income and improve living standards for themselves and their families.

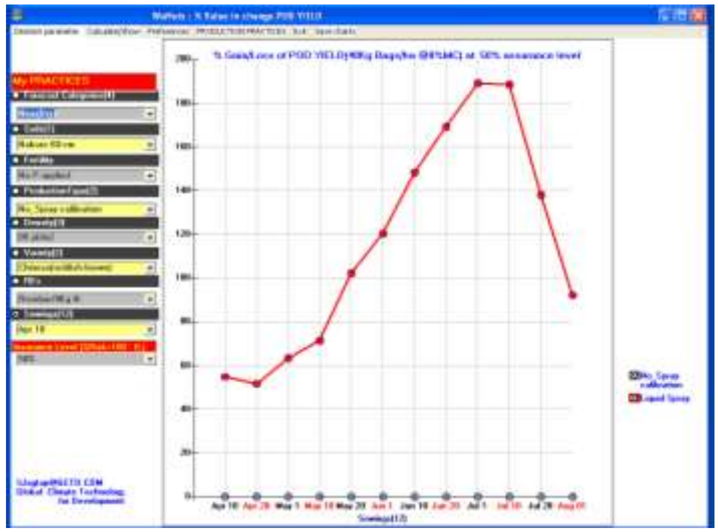
Figure 10 On-farm yields and net return from the 2007 demonstration trials.

Lessons Learnt – We have developed a climate-forecast explorer (CFE) decision support systems that will enable support services to routinely evaluate risks and opportunities for peanut production in Ghana using climate forecasts. The goal of this activity was to couple climate forecast information with crop model analyses to provide a better context for decision makers and producers, and then ask if this more elaborate information gives them any more flexibility and decision options than the climate data alone. We believe this project have had a wide-ranging operational impact on activities of support services as well as productivity and profitability of agricultural commodities in general and peanuts in particular through improved understanding and use of climate forecasts. Improved climate and weather information will lead to more informed management decisions and reduced risks for yield losses. We learns that **(1)** Farmers in the Upper West Region of Ghana are willing and eager to respond to climate forecast even with 1-month lead time and (2) Access to inputs and advice from extension agents is crucial to realize benefits from climate forecast driven advisories.

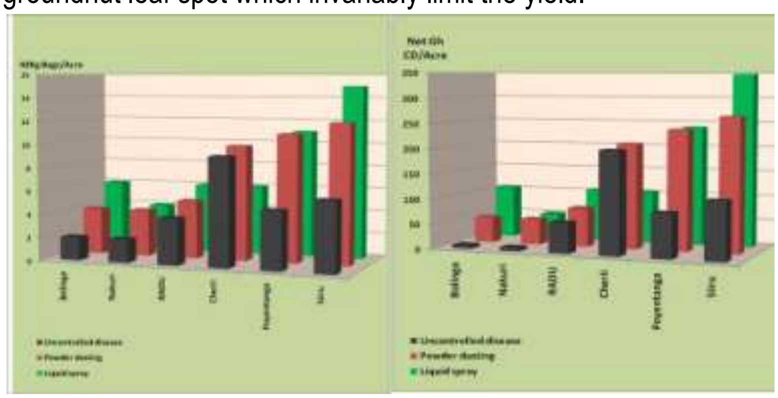
Accomplishments 6.
ROLE OF EXTENSION IN 2007 CLIMATE FORECAST DISSEMINATION

Shrikant Jagtap & E. Eledi

Background –Peanuts in the Upper West Region of Ghana suffer from high disease incidence and severities of late leaf spot (Cercospora personatum) and rust (Puccinia arachidis). We had predicted that rainfall from July to October would be above normal – and that was likely to favor formation of leaf spot disease. Analysis of forecast and recommendations using the Climate Information Explorer (CIE) showed that controlling leaf defoliation can result in 60 – 180% more yield compared to when peanuts are not sprayed depending upon the sowing time and density. Efficient disease control is possible through the use of fungicide sprays resulting in decreased leaf spot severity. However, no form of disease control is practiced by farmers, so they do not know how to handle a sprayer or chemicals. Farmers misunderstand and most often link crop maturity to leaf defoliation as a result of diseases thus overlooks the adverse effects on their crop.



2007 Forecast- It was as a result of this that groundnut demonstrations were carried out in the region to enhance the use of weather forecast information by farmers on groundnut production. The pilot districts included Wa Municipal,Wa West and East Districts. Groundnut seed to cover one-half of an acre were given to 25 farmers. Some knapsack and fungicides were purchased for the beneficiaries for the program to combat the incidence of groundnut leaf spot which invariably limit the yield.



Findings - Six demonstration trials with farmers in 2007 showed that climate forecast and associated recommendation to spray for control of leaf spots have considerable potential value to Wa farmers. This potential however was not fully realized when some of the participating farmers did not receive sufficient attention from their extension agents or did not have quality seed inputs. In spite of an organized seed sector in Wa, they do not produce certified groundnut seeds. According to our survey of 50 communities, 87% of farmers were estimated to use non-certified seeds. Using Market seeds, two of the six farmers at Bolinga and Nakuri had extremely poor germination and did not benefit from either the climate forecast or associated recommendation to spray g'nuts. Farmers in Chrii, Poyentanga and Siiru who were routinely visited and guided on how to spray their crops handsomely benefitted as these returns show.

B. Research findings

Surveys in Northern and Southern Ghana showed that groundnut was a cash crop for over 90% of households who devote 35% of their land for its production and sold 75% of their production immediately at the harvest. Farmers prefers to plant as soon as rains arrive, and those who planted early usually produced higher yields than farmers who planted later.

Majority of the uneducated farmers in Wa are likely to benefit from climate forecast and associated recommendations when (1) extension services work with them and (2) have access to good quality inputs such as seeds and chemicals for disease control.

C. Papers.

In preparation

A. 2008 Work-Plan

1. Training in climate forecast preparation and application
2. Follo-up with farmers who have been testing climate forecast products

APPENDIX